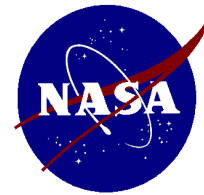




# SEE

## Bulletin

Developing Tomorrow's Space Technologies Today



NASA's Space Environment and Effects Program

Summer 1996 Issue

### Comments/Suggestions

The SEE Program Office actively solicits the following SEE related:

- Web sites
- Experiments
- Facilities
- Publications
- Conferences

for use on the SEE Homepage Web site.

If you have any comments/suggestions about the homepage and its content, please contact Billy Kauffman at:

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**The SEE Program Office would like to specifically acknowledge Sopo Yung for her outstanding effort in developing the SEE Homepage.**

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<http://elses1.msfc.nasa.gov/seeindex.html>

NASA's Space and Environments and Effects (SEE) Program has a new homepage on the World Wide Web (WWW). With expanding technology and fast growing usage of the web by industry, academia and other government institutions, the homepage was developed to provide information on SEE engineering guidelines and technology developments and their benefits to potential users. The main objective of the SEE Program is to promote participation by the SEE community to share and combine information in SEE-related technologies. The SEE Program advocates technology development, flight experiments, and databases by maintaining cutting edge expertise in these technologies.

Able to link vast bodies of information, WWW has become an economical tool for government and industry to do business. Also, the internet is fast becoming the most viable way for NASA to transfer and share knowledge.

SEE Program's placement of a homepage on the internet is another step in providing "one stop shopping" that involves space environments and its effects on spacecraft. The homepage provides SEE Program information on the current organization, technical working groups (TWG), flight experiments, technology development activities, databases, models and integrated assessments (DM & IA), SEE-related publications, and other SEE related links.

The content of the homepage emphasizes the TWGs, flight experiments and technology development activities. Forming the foundation of the SEE Program, the TWGs provide program technical content and prioritization of technological developments in response to the users needs. Made up of government, industry, and academia representatives, the TWGs direct and conduct studies and tests that meet a recognized need of the customer. At the present time, the homepage also provides a listing of the SEE related experiments and technology development activities that includes personnel information, goals and objectives of each activity.

Although the homepage is in its infancy, the SEE Program Office has many ideas on how to satisfy customer wants and needs. One is to focus on building the DM & IA. This section will include a directory of space environments databases and models that the SEE community uses to perform environments analysis. Also, it is the SEE Program's goal to provide direct access to these models in the future. Another intention is to add video segments to each TWG section and continue adding SEE experimental and technology development activity products. Because of these intentions, continual maintenance and upgrades will be documented on the "what's new" link. This page will provide information on what has recently been added to the homepage site on a quarterly basis.

Welcome to Space Environments & Effects Program



[What's New](#)  
[Introduction](#)  
[Organization](#)  
[Technical Working Groups](#)  
[SEE Related Flight Experiments](#)  
[SEE Related Publications](#)  
[SEE Related Links](#)



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 Revised: May 21, 1996

## Development of Design Standards and Guidelines for Electromagnetic Compatibility and Lightning Protection for Spacecraft Utilizing Composite Materials

*By Ross Evans, Tec-Masters Inc./MSFC*

The NASA Space Environments & Effects (SEE) program funded a task to address electromagnetic compatibility design concerns caused by the limited electrical conductivity of composite materials. The objectives of this task are to develop design guidelines relating to electrical bonding, shielding, fault current carrying capability, and lightning protection for aircraft and aerospace vehicles using composite materials.

The electrical conductivity of metallic structure and surfaces of aircraft, launch vehicles, and spacecraft is relied upon to provide a significant amount of shielding from intentional and unintentional radio frequency transmissions. The conductive metallic materials are also used as return paths to allow electrical short circuits to blow fuses or throw circuit breakers. Aluminum up to 0.25 inches thick is sometimes needed to avoid puncture by a direct lightning strike. Composite nonmetallic materials typically possess much poorer conductivity than metallic materials and usually must be enhanced if they are to provide an adequate electromagnetic shield, a circuit return path, or adequate lightning protection.

This task will include a literature search for information related to electrical properties of nonmetallic composite materials used on spacecraft, satellites, and aircraft. Tests will be performed to determine fault current carrying capability of selected materials. Simulated lightning tests will be performed to determine effects of high currents especially across joints in composite materials.

The data from the literature search was used in preparation of a preliminary design guideline that was delivered in the spring of 1996. The guideline will be updated to include the results of the tests in the spring of 1997.

## Shuttle Plume Impingement Experiment

*By Dr. Steve Koontz, NASA/JSC*

The Shuttle Plume Impingement Contamination (PIC) Experiment recently flew on STS-74 and initial results are positive. The objective of the PIC Experiment was to provide quartz crystal microbalance (QCM) measurement of both transient and persistent surface contamination produced by: 1) Shuttle Primary Reaction Control System (PRCS) engines, 2) Russian 13-kilogram (kg) attitude control and reboost thrusters on Mir, and 3) the Shuttle environment during nominal operations. The measurement objective was determined by the need to assess the impact of hypergolic engine plume impingement contamination on the functional life of sensitive International Space Station (ISS) surfaces. These assessments are important cost drivers for the ISS program because the outcome of the assessments are used to: 1) predict functional life, 2) set hardware replacement schedules, and 3) choose proximity operations scenarios. Assessments produced during Space Station Freedom (SSF), using sticking fractions estimated from ground based vacuum chamber measurements on small hypergolic engines, predicted significant degradation of both photovoltaic panels and thermal control surfaces. Particle impact damage to the Space Shuttle orbiter body flap tiles caused by Vernier engine plume impingement seemed to qualitatively confirm the assumptions about engine plume contamination used in the early SSF assessments while raising new issues in the area of surface erosion by particle impact.

Space Shuttle flight experience and CONTAM, a hypergolic engine simulation software, both suggested that the basis for the SSF engine plume effects assessment was far too conservative, and that significant cost avoidance was possible if a more realistic assessment basis could be established. The plume-sticking fraction, i.e., the mass fraction of the total plume gas flow which sticks permanently on a sensitive surface is the most important factor in the ISS contamination effects and functional life assessments. The plume sticking fraction, expressed as a percentage of engine plume mass flux, was estimated at 1.0 percent for SSF assessments.

The Shuttle Plume Impingement Experiment (SPIE) initially flew on STS-52 and revealed no detectable persistent or transient contamination. The data combined with postflight chemical analysis of hardware resulted in program acceptance of a new plume-sticking fraction percentage of .02 percent.

The Shuttle Plume Impingement Flight Experiment (SPIFEX) payload was subjected to numerous PRCS and Vernier engine plume impingement events during STS-64. Postflight chemical analysis of SPIFEX resulted in an even lower estimate of the persistent sticking fraction of 0.001 percent. The STS-74 flight experiment (PIC) was designed to verify the results of SPIE and SPIFEX on Shuttle PRCS engines while making a first set of measurements on the RUSSIAN 13 kg thrusters.


The PIC Experiment was carried out during STS-74. For the Mir 13 kg thruster measurements, the sensors were 40 feet away from the subject thruster and positioned on the engine plume axis. For the Shuttle PRCS measurements, the sensors were on plume axis, 34.7 feet away from the F3U PRCS engine. The Space Shuttle Orbiter attitude was set so that atomic oxygen ram and solar ultraviolet were incident on the QCM sensors simultaneously with PRCS engine plume impingement.

The 13 kg Mir engine and the Shuttle PRCS engine both produced transient contamination mass deposits. The initial deposit from both engine types sublimed rapidly so that the sensor output frequency was near the pre-engine firing value by the end of the experiment period indicating that little, or no, persistent mass deposition had resulted from the engine firings. The persistent sticking fraction is calculated by dividing the measured sensor mass deposition by the total engine plume mass flow delivered to the sensor location. The Mir 13 kg engine persistent sticking fraction was 0.006 percent while the Shuttle PRCS engine persistent sticking fraction was 0.007 percent.

These results confirm, within the limits of sensor sensitivity, SPIE and SPIFEX results for Shuttle PRCS engines and extend the measurement to greater sensitivity as a result of the increased numbers of firings. The first measurements of contamination produced by the Russian 13 kg engines have been made, and no persistent

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contamination has been detected which alleviates some Space Station Program (SSP) concerns about 13 kg engine plume degradation of the Active Thermal Control System radiators on the ISS. SPIE, PIC and SPIFEX provide the data needed to set the persistent plume-sticking fraction for hypergolic engines of interest to the SSP to a value on the order of 0.001 percent of the net plume gas flow for contamination assessment and functional life predictions. This confirmation of an accurate and realistic basis for performance assessment leads directly to significant SSP cost avoidance and reduced program risks. PIC measurement of transient deposition and evaporation of hypergolic engine plume deposits also provides a solid basis for evaluating the risk to crew health resulting from the deposition of toxic hypergolic plume residues on Space Station hatch covers and docking module surfaces during Shuttle proximity operations. 

### **SEE Bulletin Suggestions**

If you feel you have an article that relates to the SEE Bulletin content and would like to have it published, please contact Billy Kauffman at:

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## **SEE Program Manager's Perspective**

*By Steve Pearson*

I recently represented the Space Environments & Effects Program at a NASA Headquarters (Code XS) Integrated Planning Process Meeting. The "going in" goals of the Integrated Planning Process were:

- Align OSAT Technology development Program with user needs
- Drive direct interaction between technology developers (Level III) and technology customers (Level II) so that infusion plans and commitments (investments or funding) can be coordinated and documented
- **Note that SEE is a Level III technology developer**
- Facilitate interaction/cooperation between Level III programs
- Coordinate national technology development programs across federal agencies, particularly between NASA and DOD
- Determine more effective and more responsive investment strategy for technology development

The purpose of this specific meeting was to:

- Describe and discuss the Integrated Planning Process
- Describe and disseminate Space and Earth Mission Requirements
- Describe the required Level III (i.e., SEE) response to requirements
- Provide forum for coordination between members of each Level III Team and between Level III Teams

The major issues that affected the SEE Program was an absence of specific SEE requirements. SEE activities cut across many Level III activities instead of being identified as SEE unique activities (i.e., ionizing radiation under Level III Avionics, Atomic Oxygen under Level III Materials & Structures). We are currently reviewing the entire mission requirements database and plan to meet with each technical working group chairperson(s) to determine where the need/opportunity for SEE involvement exists.

The agency shift to smaller spacecraft has increased the importance of the Small Spacecraft Technology Initiative (SSTI) and the New Millennium programs. SSTI spacecraft primarily support remote sensing (Code Y or Mission to Planet Earth), and New Millennium has spacecraft for both the Office of Space Science (Code S) and Code Y missions. Thus, the importance of the Code S and Y customer requirements has increased. This drove a major shift for the Code XS funding

toward technology development activities in support of the Code S and Y small spacecraft mission requirements. The downsizing at Headquarters will decrease the number of Headquarters staff available for program management. In an effort to accommodate the emphasis toward smaller, better, and cheaper spacecraft and the decrease in Headquarters personnel, program management has shifted from Headquarters to the technology customer centers. For SSTI and New Millennium, the centers are GSFC and JPL. Level III technology developers report to and coordinate with the technology customers for funding. The SEE roadmaps did not originally support the change in management focus and are being reformatted to focus away from an emphasis on low Earth orbit (LEO) to emphasize responsiveness to customer requirements (particularly the Code S and Y requirements).

The Stations in Space Mission Area Center at JSC will manage the implementation plans for utilizing the International Space Station as a unique on-orbit laboratory for long duration and reconfigurable technology products.

A first step in Code XS activities involving Space Station was the "International Space Station as an Engineering Center (ISSEC)" Workshop which was held at the Johnson Space Center on May 21-22. The workshop served to introduce and involve members of academia, industry, and government in Code XS planning for ISS-related flight experiments. The core of this planning is a Cooperative Agreement Notice (CAN) to be released in late June which emphasizes facility development, cost-sharing, and a faster implementation cycle as a means to reduce costs. Participants were asked to develop technical area vision statements, identify perceived barriers to implementation of facilities and experiments, identify potential uses of the station in terms of facilities and experiments, and to comment on potential changes to the CAN in terms of scope, evaluation criteria, implementation plan, etc. Details of the CAN and the ISSEC workshop can be found on the internet at <http://issa-www.jsc.nasa.gov/ss/issec.html>. The Space Environments & Effects (SEE) discipline was one of the most heavily represented areas at the workshop.

We will try to keep you informed during this critical transition time.

*Steven D. Pearson*

**Coming in Fall 1996 Issue...**

- **Optical Properties Monitor**
- **MIR Pictorial Survey**
- **SEE Flight Experiment Opportunities**

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We are sending this issue to people we believe will be interested in the SEE Program. If you are not, please pass it on to someone else and let us know.

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Previous issues and current information can be found by visiting our homepage at:

<http://elses1.msfc.nasa.gov/seeindex.html>

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